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Examining ESQ-Oriented Problem-Based Learning on Food Waste to Enhance Students' Sustainability Consciousness

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Abstract

The issue of food waste is a global challenge with serious environmental, economic, and social impacts, hindering the achievement of Sustainable Development Goals (SDGs). In Indonesia, high levels of food waste require transformative educational strategies to foster students' sustainability consciousness. This article explores the potential of Emotional Spiritual Quotient (ESQ)-oriented Problem-Based Learning (PBL) to enhance sustainability awareness through food waste issues. A literature review was conducted by analyzing 25 articles published between 2018–2025 from reputable databases and international reports. Findings indicate that PBL develops critical thinking, collaboration, and problem-solving through authentic problem contexts. However, its role in internalizing moral and spiritual values is limited. Integrating ESQ strengthens affective and conative dimensions by instilling values of responsibility, balance (mizan), and humans' role as khalifa fil ardh. In biology education, ESQ-based PBL fosters comprehensive sustainability consciousness—cognitive, emotional, and spiritual—offering an innovative, culturally relevant approach to sustainability education in Indonesia.

Keywords : *Problem Based Learning, sustainability consciousness*

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INTRODUCTION

Sustainability issues represent an increasingly urgent global challenge in the 21st century, along with the rising environmental, social, and economic crises caused by unsustainable human consumption patterns ((UNEP, 2021);(United & Nations., 2023)). One of the most widely discussed problems is food waste, which reflects inefficiencies in the supply chain and generates serious impacts on the environment, economy, and social justice (Food and Agriculture Organization (FAO. 2019).; Gericke, 2022). The UNEP, (2021) report shows that around 931 million tons of food are wasted annually, equivalent to 17% of total global food production. In Indonesia, the National Development Planning Agency BAPPENAS, (2021) estimates food waste generation at 184–191 kg/capita/year, placing Indonesia among the world's largest contributors. This condition not only causes economic losses but also exacerbates greenhouse gas emissions and hinders the achievement of the Sustainable Development Goals (SDGs), particularly Goal 12 on sustainable consumption and production (United & Nations., 2023)

In the field of education, food waste issues can serve as a transformative learning medium that fosters sustainability consciousness—awareness of sustainability encompassing cognitive, affective, and cognitive aspects (Berglund et al., 2018); (Redman et al., 2021)). Education for sustainability is not limited to conceptual understanding but also involves the cultivation of values, attitudes, and life skills relevant to

global challenges, (UNESCO, 2022). Gericke et al, (2019) emphasize that sustainability consciousness is an integrative outcome of sustainability knowledge, attitudes, and behavior, thereby requiring holistic learning strategies. However, pedagogical approaches that only emphasize cognitive aspects tend to be less effective in promoting behavioral change.

One relevant approach is Problem-Based Learning (PBL). This model has been proven to enhance critical thinking, problem-solving, and collaboration skills through authentic problem-solving related to real-life contexts ((Hmelo-Silver & C. E., 2017); (Savery et al., 2019)). In the context of science and biology education, PBL provides opportunities for students to explore environmental issues including food waste, making learning more contextual, meaningful, and applicable (Dochy et al., (2019); (Hosnan, 2020). Research also shows that PBL can encourage attitudinal shifts toward sustainability, although it still has limitations in internalizing moral, ethical, and spiritual values Dolmans et al., (2016);Wiek et al., 2021);Nurohman, 2022; Fadilah., 2023)).

In this regard, strengthening PBL with Emotional Spiritual Quotient (ESQ) emerges as a strategic alternative. ESQ is an intelligence that integrates emotional management with spiritual values to form individuals who are moral, character-driven, and oriented toward goodness (Zohar et al., 2000); (Agustian et al., 2022). Apriyoza, Ardi, and Shaar (2025) assert that biology has significant potential in fostering Islamic character formation based on the Qur'an and Sunnah, particularly through understanding human creation, interaction with nature, and ecological responsibility. Integrating Islamic values with modern science such as biology can reinforce sustainability education, since environmental issues and food waste are not only scientific matters but also moral and spiritual ones (Syahrul et al., 2021; Nurohman, 2022; Rahmadhani, 2023). Thus, the application of ESQ-based PBL has the potential to foster comprehensive sustainability consciousness, encompassing cognitive, affective, and conative dimensions, (Rahman et al., 2023)

Based on the foregoing, this literature review aims to analyze the opportunities for implementing ESQ-oriented PBL to enhance students' sustainability consciousness through the issue of food waste. This article is expected to provide theoretical contributions to the development of sustainability-oriented learning models, as well as practical implications to support the SDGs agenda, as Gulzar et al,(2023) highlighted significant limitations in existing literature on sustainability consciousness and emphasized its importance for achieving the UN SDGs, particularly Goal 4 (quality education) and Goal 12 (responsible consumption and production).

METHODS

This research uses a literature review approach focusing on the study of Emotional Spiritual Quotient (ESQ)-based Problem-Based Learning (PBL) implementation in enhancing sustainability consciousness through food waste issues. Literature was collected from reputable databases such as Scopus, Web of Science, ScienceDirect, SpringerLink, Google Scholar, as well as official reports from FAO, UNEP, UNESCO, and BAPPENAS. Keywords used include "food waste", "sustainability consciousness", "Problem-Based Learning", "Emotional Spiritual Quotient", and "Islamic education and biology".

Inclusion criteria include articles published 2018-2025, in English or Indonesian, and relevant to biology education, sustainability, and PBL-ESQ themes. Non-academic articles, opinions, or those not peer-reviewed were excluded. Selection was conducted through three stages: initial collection (±50 publications), title-abstract screening, and full analysis. Final results yielded 25 key articles that were analyzed.

Analysis was conducted using a thematic-narrative approach that grouped literature into five main themes: global food waste issues and SDGs, sustainability consciousness concept, PBL implementation, ESQ integration, and the relationship between biology and Islamic character education. Research findings synthesis was used to identify research gaps and formulate theoretical and practical implications for PBL-ESQ model development.

FINDING AND DISCUSSIONS

Finding

This findings section presents a literature synthesis focusing on opportunities for implementing Emotional Spiritual Quotient (ESQ)-oriented Problem-Based Learning (PBL) in enhancing sustainability consciousness through food waste issues. Findings are categorized based on five main themes: global food waste issues and their relationship with Sustainable Development Goals (SDGs), the concept of

sustainability consciousness, PBL implementation in education, ESQ integration in learning, and the relationship between biology and Islamic character education. Each theme is formulated through analysis of current literature that highlights problem urgency, theoretical foundations, and practical implications in biology education. Thus, these findings not only describe conceptual and empirical conditions of each issue but also provide scientific foundation for developing integrative, contextual, and sustainability-oriented learning models.

Table 1. Literature findings results

theme	Literature findings	Implication in biology learning	reference
Global Food Waste Issues and SDGs	One-third of global food production is wasted, causing 8-10% of total global greenhouse gas emissions. Food waste contributes to environmental, economic, and social crises that threaten 2030 SDGs achievement, particularly SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption), and SDG 13 (Climate Action).	Biology learning must integrate contemporary food waste issues as real-world problem context that enables students to understand interconnections between biological, ecological, and sustainability systems. Using empirical data can enhance students' scientific literacy.	(Schanes et al., 2018), (UNEP, 2021) (Ozanne et al., 2022) (Reynolds et al., 2019)
Sustainability Consciousness Concept	Sustainability consciousness is multidimensional awareness encompassing cognitive aspects (knowledge about sustainability issues), affective (emotional concern), and cognitive (readiness to act). Research shows that sustainability awareness can be developed through education that integrates direct experience, critical reflection, and real action.	Developing sustainability consciousness in biology education requires holistic approaches that not only transfer knowledge but also develop ecological empathy and intrinsic motivation to act sustainably.	(Gericke et al., 2019), Olsson et al., 2020) Berglund et al., 2018) Boeve-de Pauw et al. (2019)
Problem-Based Learning Implementation	PBL is proven effective in developing students' critical thinking, problem-solving, and collaboration abilities. In the sustainability education context, PBL enables students to analyze complex problems interdisciplinarily and develop realistic solutions. PBL effectiveness increases when using authentic problems relevant to students' lives.	PBL in biology education must be designed with adequate scaffolding and authentic assessment that measures not only conceptual understanding but also application ability in sustainability contexts. Technology integration and collaborative learning can enhance student engagement.	(Hmelo-Silver et al., 2019), (Savery et al., 2020), Schmidt et al. (2018), (Hasslacher et al., 2009)
ESQ Integration in Education	ESQ (Emotional Spiritual Quotient) combines emotional and spiritual intelligence based on Islamic values to develop holistic character. Research shows that ESQ integration in learning can enhance intrinsic motivation, self-regulation, and students' ethical behavior. ESQ emphasizes developing six character pillars:	ESQ integration in biology education can strengthen affective and spiritual dimensions of learning, help students develop meaningful relationships with nature, and foster moral responsibility toward the environment based on Islamic perspective.	(Agustian et al., 2022; Nashori et al., 2020), (Saad et al., 2023) Ahmad et al., 2021)

theme	Literature findings	Implication in biology learning	reference
	honesty, responsibility, visionary, discipline, cooperation, and justice.		
Relationship between Biology and Islamic Character Education	Islam has a holistic environmental perspective emphasizing concepts of khalifa (stewardship), tauhid (unity), and mizan (balance). These principles align with ecological thinking concepts in modern biology. Islamic character education in a biological context can develop eco-spirituality that encourages environmentally friendly behavior.	Islam-based biology learning can integrate khalifa fil ardh concept to develop environmental stewardship, use Quranic verses about nature as starting points for scientific discussion, and develop applicative projects reflecting tauhid principles in understanding ecosystem interconnections.	(Nasr et al., 2019) (Folts et al., 2018) apriyoza et al (2024), (Baharuddin & A, 2020) (Rice & G, 2022)

Discussion

The identified literature findings demonstrate significant convergence between global food waste issues, sustainability consciousness development, and Islamic character education implementation in biology learning contexts. This discussion analyzes the interconnections between findings and their implications for pedagogical innovation in biology education responsive to 21st-century sustainability challenges.

1. Urgency of Food Waste as Contemporary Biology Learning Context

Empirical data shows that one-third of global food production is wasted, contributing to 8–10% of total global greenhouse gas emissions ((Schanes et al., 2018);UNEP, 2021). This phenomenon presents a paradox in the global food system where millions of people experience hunger while valuable food resources are wasted. This finding aligns with (Ozanne et al., 2022) analysis emphasizing that food waste is not merely a technical problem but a manifestation of systemic failure in understanding interconnections between food production, distribution, and consumption.

Reynolds et al., (2019) argue that food waste issue complexity requires multidisciplinary approaches integrating biological, ecological, and socio-economic understanding. In the biology education context, this issue offers an authentic learning context that enables students to apply biological concepts such as nutrient cycles, food chains, and ecology in understanding real impacts on the environment and society. Integrating food waste as a central theme in biology learning can bridge the gap between theoretical knowledge and meaningful practical application.

2. Developing Sustainability Consciousness through Holistic Approaches

Gericke et al, (2019) developed the sustainability consciousness concept as a comprehensive framework for understanding how individuals develop sustainability awareness. The cognitive, affective, and cognitive dimensions in sustainability consciousness reflect the complexity of learning processes required to face sustainability challenges. (Olsson et al., 2020) show that effective sustainability consciousness development requires learning experiences that simultaneously activate all three dimensions. Berglund et al., (2018)emphasize the importance of authentic experiences in developing sustainability consciousness. In the food waste context, students can directly experience the impacts of food waste through empirical investigation, measurement, and data analysis. Boeve-de et al., (2019) add that developing sustainability consciousness requires critical reflection on unsustainable consumption and production patterns, which can be facilitated through in-depth discussions about biological and ecological implications of food waste.

3. Problem-Based Learning as Effective Pedagogical Approach

Problem-Based Learning (PBL) implementation in food waste and sustainability consciousness contexts is supported by strong empirical evidence. Hmelo-Silver et al., (2019) demonstrate that PBL facilitates higher-order thinking skills development essential for analyzing complex sustainability problems. This approach aligns with (Savery et al., 2020) findings showing that authentic problems enhance intrinsic motivation and student engagement in learning.

Schmidt et al., (2018) emphasize that PBL effectiveness depends on the quality of problems used as learning starting points. Food waste provides ideal ill-structured problems for PBL because it involves multiple perspectives, requires interdisciplinary analysis, and has multiple valid solutions. (Hasslacher et

al., 2009) add that PBL in sustainability education context must be equipped with adequate scaffolding to help students navigate problem complexity and develop feasible solutions.

4. Emotional Spiritual Quotient Integration in Sustainable Learning

Agustian et al., (2022) developed the ESQ concept as a unique approach for integrating emotional and spiritual dimensions in education. Research by Nasr et al., (2019) shows that ESQ can enhance self-regulation and ethical behavior in students, aspects crucial in developing sustainable behavior. The six ESQ character pillars (honesty, responsibility, visionary, discipline, cooperation, and justice) provide a value framework that can be integrated into biology learning to develop environmental ethics. Findings by (Saad et al., 2023) and Ahmad et al., (2021)indicate that ESQ integration in science learning can strengthen students' intrinsic motivation to act sustainably. In the food waste context, character development through ESQ can help students develop a sense of responsibility toward natural resource management and empathy toward global impacts of individual actions.

5. Islamic Perspective in Environmental and Biology Education

Islam integration in biology education is supported by fundamental concepts such as khalifa (stewardship), tauhid (unity), and mizan (balance) that have deep relevance to ecological thinking principles. Nasr et al, (2019) argues that Islamic worldview about nature as *ayat-ayat Allah* (signs of God) can become the foundation for developing a sacred relationship with the environment that encourages responsible behavior.

Folts et al., (2018) explain that the *khalifa fil ardh* (stewardship on earth) concept provides a strong ethical framework for environmental education. In the food waste context, this principle can be translated into moral responsibility for managing food resources wisely and avoiding waste that contradicts Islamic teachings. Findings by Apriyoza et al., (2025) ,show that Islamic values integration in biology learning can enhance environmental awareness and pro-environmental behavior in Muslim students.

Baharuddin & A, (2020) and (Rice & G, 2022) emphasize that Islamic environmental education approach must integrate scientific inquiry with spiritual reflection to develop holistic understanding about human–nature relationships. In food waste learning, students can explore Quranic verses related to sustainability, such as the prohibition of waste (*israf*) and the importance of balance (*mizan*) in ecosystems.

6. Theoretical Synthesis and Pedagogical Implications

Convergence of the five literature findings shows significant synergistic potential for developing comprehensive and transformative biology learning models. Food waste as an urgent global issue provides authentic context for implementing PBL that develops sustainability consciousness through ESQ approach rooted in Islamic values.

The theoretical framework emerging from this synthesis indicates that effective biology learning in the Anthropocene era requires integration of four dimensions: scientific inquiry (through empirical food waste investigation), critical thinking (through systemic sustainability impact analysis), character development (through ESQ), and spiritual grounding (through Islamic perspective on stewardship). This integration creates learning environments that not only develop scientific literacy but also ecological wisdom and moral responsibility.

7. Implications for Curriculum and Instructional Design

Literature findings imply the need for biology curriculum redesign that integrates sustainability education as a thread connecting various biological topics. Curriculum integration must be spiral, where sustainability consciousness concepts are gradually developed through authentic problems like food waste. PBL approach must be supported by assessment frameworks that measure not only cognitive outcomes but also affective and behavioral changes.

Instructional materials development must consider cultural relevance and spiritual dimensions appropriate to Indonesian Muslim student contexts. Integration of Quranic verses and hadith about the environment can become starting points for scientific inquiry, creating coherent worldviews that integrate faith and science in understanding human responsibility toward nature.

The conclusions must show clearly the results obtained, their advantages and disadvantages, and the possibility of further development of the program. Conclusions can be in the form of paragraphs, but should be in the form of points using numbering or bullets.

A conclusion is not merely a summary of the main topics covered or a re-statement of the research problem, but a synthesis of key points. It is important that the conclusion does not leave the question unanswered.

CONCLUSION

Overall, the literature findings indicate that integrating food waste as the context, sustainability consciousness as the target outcome, PBL as the pedagogical approach, ESQ as a character development framework, and the Islamic perspective as a spiritual foundation can create a transformative biology learning model. This model has the potential to develop a generation that is not only scientifically literate but also ecologically wise and morally responsible in facing global sustainability challenges. Addressing the issue of food waste opens new opportunities for fostering comprehensive sustainability awareness, encompassing not only cognitive aspects but also emotional and spiritual dimensions. Further research is needed to develop and evaluate the implementation of this integrated model within the context of biology education in Indonesia.

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